

## Pulse Interlock Module

The Pulse Interlock Module (P.I.M.) has a total of 16 interlock channels.

Two of the channels are pulsed, they are:

- 1) Modulator Block
- 2) Driver RF

Fourteen channels are DC, they are:

- 1) Modulator ON
- 2) Driver Crowbar
- 3) Driver H<sub>2</sub>O Leak
- 4) PA Crowbar
- 5) PA Overload
- 6) PA Filament
- 7) PA Nitrogen
- 8) PA H<sub>2</sub>O Leak
- 9) Gas Barrier
- 10) Cavity Pressure
- 11) Cavity Water
- 12) Rad Level
- 13) RF Load
- 14) Computer

There is also an extra Lamp for Modulator Test.

All of these 16 channels are designed to protect the system. If any one of these interlocks are not met or have a fault condition the P.I.M. will provide a low at the waveform generator enable input and block the start of the gradient waveform. Each interlock channel detects different fault conditions for its reason for turning of the pulse.

### Pulsed Interlock Channels

- 1) Driver RF                      OK - Low

This channel looks for three fault conditions by setting up an RF window that detects leading and trailing edges of the driver PA forward pulse (Fig. A). If any of the leading or trailing edges enter within the boundaries of the window it will inhibit the waveform generator. The RF window (Fig. B) is a

pulse on for 10us, off for 400us, and then on again.  
These boundaries are variable.

Condition 1) If the drive RF level is too low in amplitude the P.I.M. will detect it by the RF window. The window will extend itself out to 650us (Fig. E) therefore detecting the trailing edge of the 450us driver pulse. To the window this looks as if the drive is turning off too early so the P.I.M. will terminate the gradient waveform.

Condition 2) If the driver pulse is too short the P.I.M. will detect it also by the RF window. The driver pulse (trailing edge) ended too early and entered into the window boundaries (Fig. D) so therefore a fault has occurred and the waveform generator will be inhibited.

Condition 3) If the driver pulse starts too late it is detected by the window also. The driver pulse has entered the window boundaries with its leading edge (Fig. C). This also generates a fault that will inhibit the waveform generator.

2) Modulator OK - Block

When a mod block occurs the P.I.M. will detect it and terminate the waveform generator. This will also give you a driver low condition, the reason being that the driver off pulse at 500us is terminated and the window will extend itself out to the 650us emergency off pulse therefore making the driver look like a Condition 2.

Keep in mind that all of these interlock channels have the capability of stopping the waveform generator and consequently blocking the start of the gradient waveform.

#### DC Interlock Channels

1) Modulator On - Off

This channel looks at the mod ready. If mod ready drops out the P.I.M. will stop the waveform generator. This is indicated by the Off LED.

2) Driver Crowbar OK - Fired

This channel looks for a crowbar from the driver. If a crowbar occurs the P.I.M. will stop the waveform generator. This is indicated by the Fired LED.

- 3) Driver H<sub>2</sub>O leak      OK - Wet  
Currently the PA and Driver share a humidity sensor which reads back to the PA H<sub>2</sub>O leak channel. This channel is therefore defeated. The defeat mode will be discussed later.
- 4) PA Crowbar              OK - Fired  
This channel looks for crowbars from the power amplifier. If one occurs the P.I.M. will stop the waveform generator. This is indicated by the Fired LED.
- 5) PA Overload      OK - Fault  
This channel is no longer in operation.
- 6) PA Filament              OK - Down  
If for any reason the filaments drop out or are turned down the P.I.M. will stop the waveform generator. This is indicated by the Down LED.
- 7) PA Nitrogen              OK - Low  
If the nitrogen in the 7835 cavity is low or disconnected the P.I.M. will stop the waveform generator. This is indicated by the Low LED.
- 8) PA H<sub>2</sub>O Leak      OK - Wet  
This channel checks for water in the power amplifier (7835) cavity and the driver output tube (4616) cavity, by the use of a humidity sensor. If water is in either cavity the P.I.M. will stop the waveform generator. This is indicated by the Wet LED.
- 9) Gas Barrier              OK - Hot  
This channel looks for a change in temperature from the gas barrier. This is done by a temperature probe that is stationed on the outer regions of the gas barrier. If the gas barrier gets hot the P.I.M. will stop the waveform generator. This is indicated by the Hot LED.
- 10) Cavity Pressure      OK - High  
This channel checks the vacuum ion pumps. If one or all of the pumps are turned off the P.I.M. will stop the waveform generator. This is indicated by the High LED.

11) Cavity Water OK - Low

This channel can detect several fault conditions and stop the waveform generator. If the cavity system pump is turned off manually, if the pump tripped off due to a low reservoir, or if the water is too hot. This would be indicated by the Low LED.

12) Rad Level OK - High

This channel has several things to consider.

- A) If there is a controlled access to the tunnel.
- B) If the radiation light in the tunnel is burned out.
- C) If the gradient is above a certain threshold

If all 3 conditions are true then the P.I.M. will stop the waveform generator. This would be indicated by the High LED.

13) RF Load OK - Hot

This channel is only used with the dummy load for the 4616. If the dummy load gets too hot the P.I.M. will stop the waveform generator. This will be indicated by the Hot LED.

14) Computer OK - Stop

This channel checks several things.

- A) Driver anode
- B) Driver crowbar
- C) Driver screen OV
- D) 2 IPA anode OV

Any one of these four conditions will cause a computer stop and stop the waveform generators. The computer channel can also be stopped manually. This is indicated by the Stop LED.

Mod Test

This lamp indicates that you have bypassed the 7835 by hooking up the dummy load. This allows the technician to run the modulator for test purposes.

Defeat Mode

The defeat mode is a feature designed especially for the use of the technician. Located on the front of the P.I.M.

by the reset button are two sets of 8 switches (16 T.). Each of these switches are assigned to an individual channel. If for any reason the technician would like to work on a part of the system without having an interlock fault they may defeat the part that is not operatable to continue work therefore causing the P.I.M. to think that everything is "OK" and start the waveform generator. This is indicated by a flashing OK LED.

Example: Say we would like to work on the driver crowbar circuitry because we are experiencing too many driver crowbars. We also would be able to keep the RF pulse on. We would select the defeat switch for Driver Crowbar and defeat that channel. This will cause the P.I.M to think everything is "PL" and we can start the waveform generator.

Note: These defeat switches are only to be used by the technician for test and maintenance purposes.

#### Relay Board

There are 5 relays interfaced with interlock channels in the P.I.M. These channels are:

- 1) Driver RF
- 2) Modulator Block
- 3) Driver H<sub>2</sub>O Leak
- 4) PA Filament
- 5) PA H<sub>2</sub>O Leak

These relays are located inside of the P.I.M.

DRIVER  
START

(TWO)  
DRIVER  
STOP

DRIVER  
RF LEVEL

(FIG. A)

RF  
WINDOW

VARIABLE  
183

(FIG. B)  
400US

(FIG. C)

(FIG. D)

RF  
WINDOW  
(EXTENDED)

(FIG. E)

